An Anatomy of Credit Risk Transfer between Sovereign and Financials in the Eurozone Crisis

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Abstract

In this paper we assess the effectiveness of large scale bailouts aiming at preventing a financial crisis from further propagating into a systemic risk. We examine the structural changes in the relationship between the sovereign and financial institutions' credit default swap spreads during the European sovereign debt crisis. Before the first Greek bailout by the EFSF, the sovereign and financial sectors exhibit a two-way feedback effect for both the short and the long runs. Crucially, we find that after the first Greek bailout, shocks in the financial sector either exert significantly negative impacts or lose influences on the sovereign sector. In contrast, all the later bailouts by the EFSF (the second Greek bailout, Irish and Portugal bailouts) do not show this pattern change in the two-way risk transfer relationship.

Keywords: Credit Default Risk; CDS Spreads; Sovereign Debt; Financial Institutions; European Financial Stability Facility (EFSF)

JEL: E02; G01; G13; G20; G28

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1. Introduction

The unsustainable Greek sovereign debt came to a brink of imminent default in early 2010. Propagated by the Eurozone banks' significant holdings in the Greek sovereign debt, the "Greek crisis" contagiously affected the financial sector and sovereign debt in the other Eurozone countries. Subsequently complicated by the public debt crises of Ireland, Portugal and Spain[1], the Greek crisis was rolled into a fully-fledged European sovereign debt crisis (the Eurozone crisis). The unprecedented Eurozone crisis has caused significant concerns to the policymakers. A new institution called the European Financial Stability Facility (EFSF) has since been founded by 17 Eurozone countries. The EFSF issued its first rescue package on 9 May 2010 for up to €750 billion to ensure the financial stability of Greece (G1). This is then followed by the rescue packages for Ireland on 25 January 2011 (I), Portugal on 15 June 2011 (P) and the second bailout to Greece on 21 July 2011 (G2).[2]

The goal of this paper is to understand the ways by which default risk is transferred, if any, between the sovereign countries and the domestic financial institutions during the European sovereign debt crisis. We assess the effectiveness of large scale government bailouts that aim at preventing a financial crisis from being further propagated into a two-way systemic risk.

We focus on six Eurozone countries including: Greece, Ireland, Italy, Netherlands, Portugal, Spain (the GIIPS countries) and Germany[3]. We use daily credit default swap (CDS) spreads to capture default risk, and analyze the risk transfer between sovereign and domestic financial institutions in each country from November 2007 to October 2012. We examine the structural changes in the

[1] The sovereign debt crisis in Ireland was triggered by the previous Irish banking crisis in 2008 stemming from a property bubble financed by the six state guaranteed banks. The Portugal crisis was caused by the increased public expenses such as high management costs and increased bonuses and wages to the government officers. Spain also had a housing bubble. As the housing bubble burst, the banking crisis transferred to the sovereign debt.

[2] See the Supplementary Documents for details of the EFSF guarantees and the settlements of the bailout packages for these countries.

[3] We also examine the results for Austria, Belgium, France and Netherlands, but due to the limitations of the tables, we only take Germany as the non-GIIPS country for comparison. See Supplementary Documents for the detailed results of other countries.

relationship between the CDS series of sovereign countries and financial institutions.

First, we explore the dynamic cointegration relationship with endogenous regime shifts using the model of Hansen and Seo (2002). From the analysis, we identify *typical* and *atypical* regimes where these relationships differ. The regime containing higher percentage of observations is identified as the *typical* regime, whereas the other is the *atypical* regime. We find that the identified threshold determines the regime shifts between the *typical* and *atypical* regimes. The *atypical* regime mainly resides during those periods surrounding the global credit crunch (2007-2008) and the Eurozone crisis (2010).

Further, for each of the bivariate relationships between sovereign and financial institutions, we use the model of Gregory and Hansen (1996) to detect the unknown timing of the structural breaks, which are reflected in the changes in the intercept or the slope coefficients of the model. We find that the dates of the significant breakpoints are close to the four bailouts (G1, I, P and G2) issued by the EFSF. We then use the four EFSF bailouts as the breakpoints for all the countries and investigate the changes in the default risk transfer in the pre- and post-bailout periods.

We are careful in sample coverage, and our methodology is flexible and robust to accommodate both exogenous and unobservable regime break points. Our sample period extending to 2012 allows a lengthy coverage on recent crisis evolvement and a useful time-window for analyzing the effectiveness of the EFSF bailouts. We identify regimes with the model of Hansen and Seo (2002) and verify the break points by using the model of Gregory and Hansen (1996) to detect the unknown timing of structural breaks. We find that the structural breaks coincide with the EFSF bailouts. Consequently, we use the first Greek bailout (May 2010) for the breakpoint, which is after the breakpoint surrounding the bankruptcy of Lehman Brothers in Acharya *et al*. (2014).

We find that, prior to the first Greek bailout (G1), positive interdependencies exist between the default risk of the sovereign and financial institutions. Specifically, a shock in the sovereign CDS spread of a country is followed by increases in the

CDS spread of the financial institutions in that country, and vice versa.

Most importantly we find that, after the first Greek bailout, the financial-to-sovereign risk transfer for the GIIPS countries that have high sovereign default risk becomes either insignificant or negative. This evidence indicates that the default risks of financial institutions lose their positive impacts on the sovereign default risk. In contrast, the strong and positive influences of the sovereign default risk on its domestic financial institutions remain.

On the contrary, Germany as the main EFSF guarantees is not in the two-way feedback loop even before the bailouts issued. Intuitively, the GIIPS countries are the main beneficiaries of the bailouts, the financial-to-sovereign risk transfer in the GIIPS countries breaks down after the bailouts. The evidence suggests that since the G1 bailout is supported by the EFSF guarantee countries, the bank-to-sovereign risk transfer in the two-way feedback breaks down, and the sovereign risk is transferred to the other bailout guarantees.

Moreover, for later bailouts in Greece (the second bailout), Ireland and Portugal, we find that the default risk transfer from financial sector to government becomes insignificant. This evidence supports the initiative of large-scale bailouts by the EFSF: the first Greek bailout (G1) has been a success in breaking the bank-to-sovereign risk transfer, and in ending the two-way feedback loop. These effects are not only beneficial for Greece, but also for the other countries such as Ireland, Portugal and Spain. Our evidence derives a policy implication that a determined large bailout, such as G1, is indeed capable of preventing the exaggeration of risk transfer from the financial to the sovereign sector.

Previous theoretical literature on the bank bailouts mainly focuses on the costs and benefits of the bank bailouts at the individual level (Mailath and Mester (1994)) and at the aggregate level of the banking sector (Penati and Protopapadakis (1988) and Acharya and Yorulmazer (2007)). While on the other hand, the theoretical literature on the sovereign default risk focuses on the collateral impacts of sovereign defaulting on the financial sector through bank holdings of the government debt from domestic or foreign countries (Broner *et al*. (2008), Acharya and Rajan (2013)

and Gennaioli *et al*. (2010)). Acharya *et al*. (2014) consider the effects from the both sides and define the default risk transfer between the sovereign and financial sectors as a "two-way feedback" effect.

Previous empirical studies on financial crisis before 2010 show that increases in sovereign default risk may reduce foreign credit to the domestic private sectors via a decline in credit supply (see, e.g., Drudi and Giordano 2000; Dooley and Verma 2001; and Tomz and Wright 2008). The increased sovereign default risk also causes a decrease in the aggregate demand of credit. Kim and Wu (2008) show that sovereign credit ratings raise sovereign credit ratings have positive impacts on domestic stock markets and the banking sector. The other related study is Alter and Schüler (2012) who analyze the impacts of bank bailouts during the period 2007-2010 on the interdependencies between the sovereign and banking sectors, and conclude that the contagion (default risk transfer within domestic countries) disperses into different directions after the bank bailouts.

Acharya *et al*. (2014) use OLS to estimate relation between the changes in CDS of the banking and the sovereign sector and find that positive "two-way feedback" interdependencies exist between the sovereign and the financial default risks during the post-bailout period. They interpret that since governments and banks hold debts of each other, a bailout injection into the banking sector could cause a two-way feedback effect between the two sectors. In contrast, our study sheds important insight into the effectiveness of large scale bailouts in preventing a financial crisis, while our evidence complements the findings of Acharya *et al*. (2014). Our evidence shows that, before the first Greek bailout, the risk transfers have been positive, both sovereign-to-banks and the banks-to-sovereign, indicating that these countries have entered into a feedback loop. Our finding of the two-way feedback between the sovereign and financial sectors during the pre-bailout period, which covers the whole sample period in Acharya *et al*. (2014), is consistent with Acharya *et al*. (2014).

The remaining parts of the paper are organised as follows. Section 2 explains the mechanism of risk transfer between the sovereign and financial sectors. We use Greece for illustration purpose as our evidence points toward the effectiveness of the

first Greek bailout. Section 3 describes the data and our sample. Section 4 explains our estimation methodology. Section 5 analyzes the results and reports our findings. Section 6 concludes.

2. The Risk Transfer Mechanism

In Figure 1 we illustrate the risk-transfer mechanism in the case of Greece. As detailed in our analysis later, before the first Greek bailout issued by the EFSF, a "two-way feedback" effect exists between the default risks of sovereign and the financial sector, indicating positive interdependences. After Greece starts the application of the EFSF bailout to support its financial sector, the bailout burden is shared by the other EFSF guarantees such as Germany and even by the whole Eurozone in the short run. The Greek government then receives the bailout from the EFSF guarantees. Thus, instead of Greece taking over the debt of its own financial sector, the default risk gets transferred to other Eurozone countries. Hence, the bank-to-sovereign risk transfer in this two-way feedback loop breaks down after the EFSF bailouts issued. We term this as the "Greek effect".

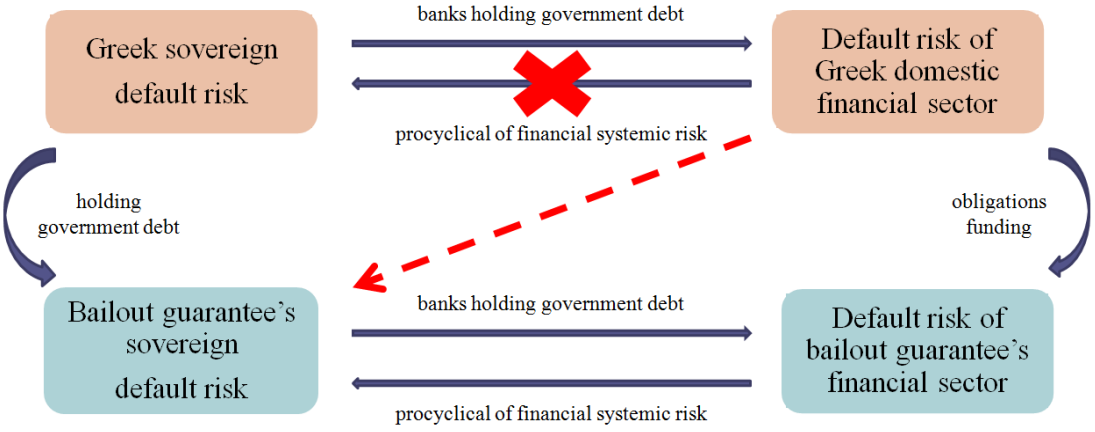

Figure 1. "Two-way feedback" loop using Greece as an example. Before any bailout interventions, a "two-way feedback" effect exists between the default risks of sovereign and the domestic financial sector of Greece and other countries. After the bailouts, the positive feedback from the Greek financial sector to the Greek sovereign sector might be broken down and transferred to other countries, as the other Eurozone guarantee countries are taking over the bailout debt burdens together

The result of this Greek effect is the lack of "the two-way feedback effect" when

Ireland and Portugal received bailouts from the EFSF later. This is because the default risk had already been priced during the first Greek bailout. This reflects the perception of market participants in that these countries may also request and would be granted bailouts from the EFSF in the future. Thus the price of the default has been adjusted after the first Greek bailout.

Our findings also indicate that the outcomes of other bailouts are heterogeneous among the European countries. The private-to-public risk transfer was influenced in Ireland, Portugal and Spain during the first Greek bailout, but not in other countries such as Germany which has more stable financial system. Dieckmann and Plank (2012) report that the states of the financial system at the beginning of the financial crisis have strong explanatory power for the private-to-public risk transfer, and that an Economic and Monetary Union (EMU) member is more sensitive to the health of its pre-crisis financial system.

On the other hand, "the two-way feedback" effect between a government and its own domestic financial sectors prior to the first Greek bailout issued by the EFSF can be understood as follows. When a country faces financial distress, be it stemming from high public deficit or heavy debt burdens, the sovereign default risk of this country rises and the sovereign debt devalues. In the short run, (i) for the domestic financial institutions the cost of holding the sovereign debt is higher, which impacts the balance sheet of the financial institutions; (ii) for other governments that support the financially distressed country by providing bailout packages, the sovereign and financial sectors of the supporting countries also face higher default risk for holding the devaluated sovereign debt. The financial systemic risk, which is the impacts of macroeconomic factors on banking credit risk, is procyclical to the business cycle or macroeconomic environment (see, Borio *et al*. 2002; Marcucci and Quagliariello 2009; and Festic, *et al*. 2011). In the long run, sovereign debt crises are followed by reductions in foreign capital inflows as investors' awareness to the sovereign default risk increases, and the domestic credit becomes more expensive, which negatively affects the domestic economy and hence increase the default risk of the domestic financial institutions.

Likewise, increased default probability of a financial institution increases the likelihood that the counterparties may find themselves facing funding difficulties, thereby increasing the default risk of the counterparties. A systemic financial crisis thus arises and hampers the economy, which in turn, deteriorates public finances, resulting in higher sovereign default risk.

In order to combat a potential systemic financial crisis, a government can issue a bailout to domestic financial institutions via increasing taxes or diluting existing government debt (hence raising the insolvency ratio). However, bailouts are costly, and increased taxation transfers the burden of default risk from the public to the private sectors. A Government that issues bailouts has to sacrifice its credit risk, which means that domestic bailouts can drive the risk transfer into a vicious two-way feedback loop.

3. Data and Sample

Our analysis uses credit default swap (CDS) spreads to capture credit default risk of an institution, or the government. Prior studies have shown that CDS spreads can measure investors' risk preference. According to Hull *et al*. (2004), both changes and levels of CDS spread contain significant information in estimating the probability of rating events. Changes in CDS spread are conditional on rating events, and downgrade announcements and negative outlooks do not have helpful information. Ismailescu and Kazemi (2010) analyze the relationship between the sovereign CDS spreads and the sovereign credit ratings, and show that investors can make decisions according to the same public information that would lead to the changes in CDS spreads prior to a rating announcement. Düllmann and Sosinska (2007) analyze the CDS spreads of banks, and document that banks' CDS spreads indicate banking credit risk from three risk sources including idiosyncratic risk, systematic risk and liquidity risk.

The daily data of CDS spreads is collected from Datastream. The selection of financial institution and sovereign CDS series is restricted by data availability. Cyprus, Estonia, Slovakia, and Slovenia are excluded because data of corporate CDS series are not available; Luxemburg is excluded as no data of sovereign CDS series

are provided; Malta is excluded as neither corporate nor sovereign CDS series are available; and Finland is excluded because CDS series data of financial institutions are not available.

We analyze six Eurozone countries, including Greece (GR), Ireland (IE), Italy (IT), Portugal (PT), Spain (ES) (the GIIPS countries) and Germany (DE)[4], together with their domestic financial institutions. Greece, Ireland, Portugal and Spain have requested for the bailout funding from the EFSF, and Italy has also been facing severe default risk. Germany is the main guarantee of the EFSF that has contributed the most to the bailouts. For each country, except for Greece which has one financial institution, we analyse the largest and the smallest financial institutions by total assets[5]. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal), Banco Santander and Banco De Sabadell (Spain), and Deutsche Bank and Hannover Re (Germany). The CDS series of the financial institutions are chosen according to the Standard Industrial Classification (SIC) code of the institutions (major groups 60-67, including Finance, Insurance, and Real Estates), respectively.

Our study uses five-year CDS since it is the largest and the most liquid constituent of the CDS markets[6]. Our sample starts from 13 November 2007. The Greek CDS series stops on 17 February 2012 because Greek debt restructuring triggered approximately $3.2bn CDS credit protection payout on Greek sovereign debt in early March 2012. The CDS series for other countries extends until 08 October 2012.

To investigate the sovereign-and-bank interdependencies for the first Greek

[4] We also examine the results for Austria, Belgium, France and Netherlands, but due to space constraints, we only report Germany as the non-GIIPS country for comparison. The results of other countries are available on request.

[5] For Ireland, Italy, Spain and Germany, we examine the results for more than three financial institutions in each country. Due to space constrains, we only report the results of the largest and the smallest financial institutions. The results of other financial institutions in these countries are available on request.

[6] The restructuring type of the sovereign CDS series is Complete Restructuring (CR), as it is the only restructuring clause applied by the sovereign CDS series. The restructuring type of the financial institutions is Modified-Modified (MM) Restructuring. The MM restructuring clause has been introduced and applied by the European market participants since 2003.

bailout (G1), we use the G1 bailout date (9 May 2010) to separate the data set into two sub-periods[7]. For later bailouts by the EFSF (I, P and G2), we set breakpoints according to the respective bailout dates (see section 5.3).

Panels A, B and C of Figure 2 display the co-movement of the sovereign CDS spreads and the CDS spreads of domestic financial institutions in Greece, Ireland and Portugal, respectively. The bailout periods for Greece (first (G1) and second (G2) bailouts), Ireland (I) and Portugal (P) are displayed. Before February 2010, the sovereign CDS spreads of all the countries were low and stable. The sovereign CDS spreads of the GIIPS countries increase significantly after the first Greek bailout (G1), indicating that these countries have been suffering severe sovereign default risk during the Eurozone crisis. Except for the Greek sovereign CDS spreads remaining high, the sovereign CDS spreads of other countries have started to come down since the second Greek bailout (G2). The CDS spreads of the institutions increased after the Greek first bailout (G1), and then reached the peak at the second Greek bailout (G2).

[Insert Figure 2]

4. Estimation Methodology

We analyze the default risk between the sovereign and financial sectors in two stages.[8] First, we apply the model of Hansen and Seo (2002) to test a threshold relationship in dynamic regimes and apply the model by Gregory and Hansen (1996) to detect the structural breaks in each bivariate relationship. We examine and that the

[7] On 9 May 2010, the European Financial Stability Facility (EFSF) set out the first bailout package to Greece worth up to €750 billion aiming at rescuing financial stability across the European countries.

[8] Prior to the estimation of the VAR and VEC models, we test the unit roots of the log-level CDS spreads and the first differences of the log levels using the augmented Dickey-Fuller (ADF) test (detailed results available on request). To test the cointegration of the $I(1)$ variables for each bivariate model, Johansen's trace tests are applied except for the ADF tests (see Appendix 1). If the variable in log-levels can be cointegrated, i.e., reject maximum rank at 0 or 1, we proceed to estimate the VEC. The optimal lag order p in the VAR and the VEC models is determined by, on the one hand, minimising the common information criteria in the underlying VAR model of the log-levels, and on the other hand considering autocorrelations of the residuals and joint tests of reducing unnecessary lags in the models. The VEC model is estimated via Johansen's maximum likelihood method and the VAR model via ordinary least squares.

structural breaks coincide with the EFSF bailouts. We then use the breakpoints for all the countries to investigate the changes in the default risk in the pre- and post-bailout periods.

Second, to examine the long-run cointegration between the two sectors, we use the vector autoregression (VAR) and the vector error correction (VEC) models in each of the periods of the identified regimes. For the short-run analysis, we apply the impulse response functions (IRFs) to capture the differences of shock transmitting mechanism between banks and country. Since each bank responds differently to shocks in a country, we estimate IRFs separately for each pair of bank and country. As such, there is no common market-wide effect. We control for bank and sovereign fixed effects by estimating the models separately for each pair of bank and country.

4.1. Two-Regime Threshold Cointegration in VEC Model

We estimate threshold VEC models using the variables $cds_{Sov,t}$, the log of sovereign CDS spreads (in short '*Sov*') and $cds_{Fi,t}$, the log of CDS spreads of a domestic financial institution (in short '*Fi*'), as proposed by Hansen and Seo (2002).

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{cases} \mu_1 + \begin{pmatrix} \alpha_{Sov,1} \\ \alpha_{Fi,1} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i,1} & \gamma_{SovFi,i,1} \\ \gamma_{FiSov,i,1} & \gamma_{FiFi,i,1} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_{1t}, \quad if \ w_{t-1} \le \gamma, \\ \mu_2 + \begin{pmatrix} \alpha_{Sov,2} \\ \alpha_{Fi,2} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i,2} & \gamma_{SovFi,i,2} \\ \gamma_{FiSov,i,2} & \gamma_{FiFi,i,2} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_{2t}, \quad if \ w_{t-1} > \gamma, \end{cases}$$

where $w_{t-1} = cds_{Sov,t-1} + \beta cds_{Fi,t-1}$, which is the estimated cointegrating relationship between the two CDS series. Once the threshold (γ) is estimated and conditioned, the regime with higher percentage of observations is defined as the *typical* regime, and the other is defined as the *atypical* regime. In the *typical* regime, $\Delta cds_{Sov,t}$ and $\Delta cds_{Fi,t}$ have minimal error-correction effects and minimal dynamics. In the *atypical* regime the two series deviate more from the long-term cointegration, meaning that the error-correction effect is stronger.

4.2. Testing the Unknown Timing of Structural Breakpoints

We also apply the models of Gregory and Hansen (1996) to detect statistical breakpoints in each bivariate relationship, and to check whether the actual bailout events coincide with the statistical breakpoints. The model of Gregory and Hansen

(1996) treats the timing of a structural change as unknown. The structural change would be reflected in changes in the intercept and/or the slope coefficients. The models are expressed as a Level Shift (C) when there is a break in the intercept only, or a Regime Shift (C/S) when there is a break in the intercept and the slope of the cointegrating relationship.

The null hypothesis is that there is no cointegration between the two variables in the presence of a regime shift at unknown timing. The *ADF*-, Z_α-, and Z_t-type tests are taken to test the null hypothesis, and the critical values are calculated by simulation methods.

4.3. IRF of VAR and VEC Models: Pre- and Post-Bailout Periods

The analysis in Section 4.2 shows that there are breaks near the EFSF bailouts. We therefore use the VAR and VEC models to analyse the pre- and post-bailout risk transfer between the sovereign and financial sectors. Subsequently, we use the EFSF bailouts as the breakpoints for the whole period. For example, for the first Greek bailout, we use the bailout date as the only breakpoint to separate the data into the pre- and the post-bailout sub-periods and analyze the bivariate relationship in each country in both the sub-periods. We estimate the VAR and VEC models with a sovereign CDS spread and a domestic financial institution's CDS spread.

We use impulse response functions (IRF) of VAR models using the log CDS spreads. IRFs are used to depict the impacts of one-time shock to a '*Sov*' (a domestic '*Fi*') within one standard deviation not only on the '*Sov*' ('*Fi*') itself but also on the domestic '*Fi*' ('*Sov*') of current (1, 2 and 5 days) and future (22 days) periods.

5. Empirical Findings

5.1. Results from Two-Regime Threshold VEC Model

This section reports the estimation of Hansen and Seo's (2002) model for detecting *typical* and *atypical* regimes and for testing cointegrating relationship between the default risk of the sovereign debts and financial institutions.

[Insert Table 1, 2 and 3]

Tables 1, 2 and 3 show the cointegration results of the linear VEC model without threshold, *typical* regime and *atypical* regime, respectively. For exposition

purpose, we use as an example the log CDS spreads of Greek sovereign debt and the log CDS spreads of Alpha Bank (see Table 1, 2 and 3). The estimated VEC without a threshold effect is given below

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.00)}{0.011} + \underset{(0.00)}{0.002} w_{t-1} + \underset{(0.04)}{0.127} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.012} \Delta cds_{Fi,t-1}, \\ \Delta cds_{Fi,t} = \underset{(0.00)}{0.019} + \underset{(0.00)}{0.006} w_{t-1} + \underset{(0.04)}{0.035} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.017} \Delta cds_{Fi,t-1}, \end{cases}$$

where the cointegrating relationship is $cds_{Sov,t} = 1.418 cds_{Fi.t} - 0.235$. Then the model by Hansen and Seo (2002) is used, the estimated cointegration is $w_t = cds_{Sov,t} - 1.451 cds_{Fi.t}$, and the estimated threshold is -1.001.

The estimated threshold VEC is shown below:

Typical regime

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.01)}{0.021} + \underset{(0.00)}{0.005} w_{t-1} + \underset{(0.04)}{0.105} \Delta cds_{Sov,t-1} - \underset{(0.01)}{0.009} \Delta cds_{Fi,t-1}, \\ \Delta cds_{Fi,t} = \underset{(0.01)}{0.011} + \underset{(0.00)}{0.003} w_{t-1} + \underset{(0.02)}{0.042} \Delta cds_{Sov,t-1} - \underset{(0.02)}{0.018} \Delta cds_{Fi,t-1}, \end{cases} \quad w_{t-1} \le -1.001,$$

Atypical regime

$$\begin{cases} \Delta cds_{Sov,t} = \underset{(0.02)}{-0.015} - \underset{(0.02)}{0.019} w_{t-1} + \underset{(0.08)}{0.500} \Delta cds_{Sov,t-1} - \underset{(14.01)}{41.752} \Delta cds_{Fi,t-1}, \\ \Delta cds_{Fi,t} = \underset{(0.21)}{-0.218} - \underset{(0.32)}{0.332} w_{t-1} - \underset{(0.20)}{0.102} \Delta cds_{Sov,t-1} - \underset{(46.60)}{39.964} \Delta cds_{Fi,t-1}, \end{cases} \quad w_{t-1} > -1.001.$$

From the above, the relatively usual regime occurs when $cds_{Sov,t} \le 1.451 cds_{Fi.t} - 1.001$, with 94% of the observations in this regime, and this is defined as the *typical* regime. The other regime (with 6% of the observations) is defined as the *atypical* regime when $cds_{Sov,t} > 1.451 cds_{Fi.t} - 1.001$.

The coefficient of $\Delta cds_{Sov,t}$ in the *atypical* regime is 0.500, which is much larger than the coefficient in the *typical* regime (0.105). The other coefficients of $\Delta cds_{Sov,t}$ and $\Delta cds_{Fi,t}$ in the *atypical* regime are insignificant in this case. However, comparing the results of Table 2 and 3, in general the absolute values of

the coefficients of $\Delta cds_{Sov,t}$ and $\Delta cds_{Fi,t}$ in the *atypical* regime are much larger than those in the *typical* regime. The estimated results indicate that in the *typical* regime, $\Delta cds_{Sov,t}$ and $\Delta cds_{Fi,t}$ have minimal error-correction effects and minimal dynamics, while in the *atypical* regime the error-correction effect is stronger.

Figures 3 shows, respectively, the CDS spreads of sovereign debts and financial institution in each of the GIIPS countries, together with the *typical* and *atypical* regimes estimated from the threshold VEC model. For example, the first figure shows the co-movements of CDS spreads of Greek sovereign debt and Alpha Bank. The grey areas indicate the *typical* regime, and the white areas (in early 2008 and March 2012) show the structural breaks or the *atypical* regime of the two CDS series. The four vertical lines indicate the four bailouts issued to Greece (two bailouts), Ireland and Portugal by the European Financial Stability Facility (EFSF) during the Eurozone crisis. The findings show that the *atypical* regime usually happens when the co-moving trend of the bi-variables changes, indicating the cointegration relationship between the bi-variables changes. Moreover, the *atypical* regime shows that the structural breaks mainly locate around the global credit crunch period (2007-2008) and the Eurozone crisis.

[Insert Figure 3]

After displaying the *typical* and *atypical* regimes of each pair of bi-variables, we analyze the impulse responses of all the GIIPS countries in different regimes. Table 4 shows the impulse responses of the five countries in the two regimes. The responses after 1, 2, and 5 days represent the short-term effect, and the responses after 22 days show the long-run effect. For example, in the *typical* regime, the responses of *Alpha Bank* to the impulse in *Greek Sov* after 1, 2 and 5 days are 0.04, 0.06 and 0.09, respectively, and the response after 22 days is 0.27. The responses of *Greek Sov* to the impulse in *Alpha Bank* after 1, 2 and 5 days are -0.01, -0.02 and -0.04, respectively, and the response after 22 days is -0.11.

[Insert Table 4]

We observe that, for the GIIPS countries except Greece, in the *typical* regime, a

two-way feedback effect exists between the default risk of the sovereign and financial sectors, as most of the responses of financial institutions to the sovereign CDS shocks are significantly positive, and vice versa, in both the short and long run. For example, for the pair of *Irish Sov* and *Bank of Ireland*, the responses of *Bank of Ireland* to the impulses in *Irish Sov* after 2, 5 and 22 days are significantly positive (0.04, 0.09 and 0.27, respectively); the responses of *Irish Sov* to the impulses in *Bank of Ireland* after 1, 2, 5 and 22 days are also significantly positive (0.11, 0.10, 0.11 and 0.13, respectively). Importantly, in the *atypical* regime, we find that while the positive interdependencies between the sovereign and financial sectors remain significant, the responses to the changes in the impulse variables become much larger generally than that in the *typical* regime. For the pair of *Irish Sov* and *Bank of Ireland*, the responses of *Bank of Ireland* to the impulses in *Irish Sov* after 1, 2, 5 and 22 days are significantly positive (0.14, 0.15, 0.27 and 0.40, respectively); the responses of *Irish Sov* to the impulses in *Bank of Ireland* after 1, 2, 5 and 22 days are also significantly positive (0.13, 0.12, 0.19 and 0.27, respectively). These results indicate, as explained in Section 2, that the sensitively of the financial institutions' default risk to the sovereign default risk increase for these countries, and vice versa.

In comparison, the interdependent relationship between the sovereign and financial sectors of Greece is different from other GIIPS countries. In the *typical* regime, the impact of sovereign default risk on the default risk of the domestic financial sector is positively significant, whereas the impact of domestic financial sector on the sovereign sector remains insignificant. In the *atypical* regime for Greece, the impacts of the sovereign default risk on the default risk of the financial institutions are reduced to zero. In a sharp contrast, the sovereign default risk exhibits strong and negative responses to the shock in the default risk of the financial institutions. For example, in the *atypical* regime, the responses of *Greek Sov* to the impulse in *Alpha Bank* after 1, 2 and 5 days are -34.99, -33.03 and -24.83, respectively. Such heterogeneous results in Greece indicate that in the *atypical* regime the negative force of the impact of the financial sector on the sovereign default risk is much stronger than the positive force. This is because the state of the

financial system of a country since the beginning of the financial crisis has strong explanatory power for the private-to-public risk transfer. For Greece, as the government debt has been already relatively high before and at the beginning of the credit crunch period, the sensitivity of the sovereign default risk to a shock in the domestic financial sector is exaggerated when Greece has to issue more sovereign debt in later crisis.

5.2. Determining Structural Breakpoints

In this section, the tests (as described in section 4.2) of Gregory and Hansen (1996) are applied to detect structural breaks in the log-CDS series. We use the log-CDS series of Greek sovereign debt and Alpha Bank for exposition purpose, and Table 5 shows the results. In Panel A of Table 5, the results in the *ADF,* Z_t and Z_α tests using the regime shift (*C/S*) model suggest that the breakpoints are on 12 May 2010 and 21 September 2011. The date of the first breakpoint is very close to the first Greek bailout on 9 May 2010.

[Insert Table 5]

Likewise, we detect the breakpoints in the CDS series of Ireland, Italy, Portugal and Spain using the Gregory and Hansen (1996) models. Panel B of Table 5 shows the summary of the level shift (*C*) and the regime shift (*C/S*) breakpoints for the GIIPS countries. These significant breakpoints are close to the four bailouts (G1, I, P G2) by the EFSF, indicating that the bailouts change the pattern of interdependencies of the default risk between the sovereign and financial sectors. Thus, setting sub-periods according to the timing of the EFSF bailouts is both intuitive and supported by statistical evidence.

5.3. Default Risk Transfer: Pre- and Post-Bailout Periods

As we show earlier, the actual bailout dates are close to the breakpoints of the CDS series, for the time period of the first Greek bailout, we use the G1 issue date (9 May 2010) as the breakpoint for the GIIPS countries and Germany. For later EFSF

bailouts (I, P and G2)[9], sub-periods are set for Greece, Ireland and Portugal according to the country's application and/or bailout dates, respectively.

Five sub-periods are set for Greece. The first period, pre-bailout period, ending at 9 May 2010, is the settlement date of the first tranche of the bailout worth €20 billion. The official request for rescue from the Greek government was issued on 23 April 2010, and a three-year financial aid programme (loan commitments) worth €110 billion was agreed on 2 May 2010 by the European Union (EU), European Central Bank (ECB), and International Monetary Fund (IMF).[10] As the application period before the first bailout is short, we include this period into the pre-bailout period. The first bailout period starts from 10 May 2010 and ends on 21 July 2011, which is the approval date of the second rescue package agreed by the 17 EFSF guarantees. The application period of the second bailout ends on the date of the final agreement by the EFSF (20 February 2012), and the second bailout period is between the date of the final agreement and the settlement of the last tranche (28 June 2012). The post-bailout period follows the second bailout period.[11] As shown in Figures 2 and 3, the Greek sovereign CDS spreads have kept increasing from 354.77 bps to 14904.36 bps. On the other hand, the CDS spreads of *Alpha Bank* have started to decrease since the second bailout period. This difference in the sovereign and banking CDS spreads suggests, as in the last section, that the financial sector might have transferred part of the credit default risk to the sovereign balance sheets in Greece. Acharya *et al*. (2014) show similar results that the sovereign CDS spreads increase, while the banking CDS spreads decrease in the post-bailout period of the previous financial crisis.

The programme for Ireland has been separated into four sub-periods. The pre-bailout period is separated into the period before application and the application

[9] Spain is not included in this section. Although the Spanish government issued the official request for financial bailout to the EFSF on 25 June 2012, the EFSF has not confirmed the settlement dates of bailouts.

[10] The first Greek bailout programme has been discontinued, and the remaining amount (€24.4 billion to be disbursed by the Eurozone countries) has been transferred to the EFSF.

[11] The sovereign CDS spread of Greece has remained unchanged due to Greek debt restructuring in early March 2012, thus there is no further analysis of Greek risk transfer for the bailout and post-bailout periods during the second Greek bailout.

period. The application period starts after 21 November 2010, which is the date the Irish government made official request, and ends before 25 January 2011, which is the issue date of the first tranche worth €5 billion. The bailout period is between the issue date of the first tranche and the settlement date of the final tranche on 03 April 2012, and the post-bailout period afterwards. As shown in Figures 2 and 3, both the banking and sovereign CDS spreads have kept increasing from the period before application to the post-bailout period in Ireland. The rescue programme for Portugal is also set into four sub-periods, and the methodology to set sub-periods is similar to that of Ireland. The breakpoints for Portugal are 06 April 2011, 14 June 2011 and 17 July 2012. For Portugal, both the banking and sovereign CDS spreads have dropped significantly in the post-bailout period.

5.3.1. Results of First Greek Bailout

Table 6 reports the results of cointegration analysis for the GIIPS countries and Germany before and after the first Greek bailout issued by the EFSF.

[Insert Table 6]

According to the VEC model, β_{Sov} and β_{Fi} reveal the long-term relationship between the sovereign and the financial institution's default risks. Normalizing β_{Sov} to 1 we get:

$$cds_{Sov,t} = -\beta_{Fi} cds_{Fi,t} + \beta_0$$

Thus a negative β_{Fi} indicates that the relationship between the two sectors is positive. In Table 6, the results show that the β_{Fi} coefficients of the GIIPS countries and Germany are significantly negative (except the pair of *Spanish Sov* and *Banco De Sabadell* before the bailout in Panel A), for the periods both before and after G1. For examples, the β_{Fi} coefficients of *Alpha Bank*, *Banca Popolare De Milano* and *Deutsche Bank* are significantly negative before G1 (-0.83, -21.98 and -3.94, respectively) and after G1 (-2.08, -0.68 and -1.50, respectively). The coefficients α_{Sov} and α_{Fi} measure the speed of adjustment towards the long-term relationship. The coefficients are significant and have opposite signs to their respective β coefficients, indicating that the CDS series are attracted back to the long-run equilibrium.

Next, we analyze the results of impulse responses of all the countries (GIIPS and Germany). Table 7 shows the results of IRFs for GIIPS and Germany before and after the first Greek bailout (G1). The responses after 1, 2 and 5 days represent the short-term effects, and the responses after 22 days reveal the long-run effects.

Before G1, the results show that a two-way feedback effect exists for the GIIPS countries. Specifically, most of the responses of financial institutions to the sovereign CDS shocks are significantly positive, and vice versa, for both the short and long run. The results indicate that prior to the first Greek bailout, changes in the sovereign default risk affect the credit default risk of the domestic financial institutions, and vice versa. For example, the responses of *Bank of Ireland* to the impulses in *Irish Sov* after 1, 2, 5 and 22 days are significantly positive (0.05, 0.06, 0.08 and 0.17, respectively), and the responses of *Irish Sov* to the impulses in *Bank of Ireland* after 1, 2 and 5 days are also significantly positive (0.14, 0.14 and 0.12, respectively).

[Insert Table 7]

After G1, there is significant effect of default risk transfer in both the short and long run for the GIIPS countries. The responses of the financial institutions to the sovereign CDS shocks are significantly positive and are even larger than those before G1, indicating that the domestic financial institutions are affected stronger by the shocks in sovereign default risk after the bailout. For example, after G1, the responses of *Bank of Ireland* to the impulses in *Irish Sov* after 1, 2, 5 and 22 days are significantly larger (0.28, 0.32, 0.46 and 0.82, respectively). On the other hand, the responses of the sovereign CDS to the domestic financial institutions become either insignificant or significantly negative for most variables after the bailout. The responses of *Irish Sov* to the impulses in *Bank of Ireland* after 1, 2 and 5 days become insignificant (0.03, 0.03 and 0.04, respectively). The results of other GIIPS countries show similar pattern. This indicates that the default risk transfers from the financial sector to the government after the EFSF interventions, and the relieved default risk of the financial institutions becomes heavier debt burdens to the government. In addition, changes in the default risk of the financial institutions can

have negative impacts on the sovereign default risk.

Germany shows different results of impulse responses. Before G1, larger *Deutsche Bank* shows a two-way feedback with respect to *German Sov*, but for the smaller *Hannover Re*, the two-way feedback effect is not significant. After G1, there is no pattern of risk transfer between the sovereign (*German Sov*) and financial sectors (*Deutsche Bank*/*Hannover Re*). Such results indicate that the non-GIIPS governments (as represented by Germany) and their domestic financial sectors are not facing severe debt crisis, and the governments do not have to take over the default risk from their financial sector. The different results of GIIPS and Germany are consistent with the notion that the heterogeneity of the rescue packages across the countries translates into the asymmetric interdependent relationship between the default risk of the sovereign and financial sectors.

Our empirical results show that the default risk transfer may occur based on the current financial situations of the governments and their domestic financial sectors. Also the direct capital injection into the financial sector may not relieve the sovereign debt crisis. Instead, it further magnifies the impacts of sovereign default risk on financial sector through increases in the government debt burdens.

Our results are different from the results of Acharya *et al*. (2014). Acharya *et al*. (2014) find that during the pre-bailout periods, there is no sovereign-to-banking risk transfer, but after the bailout, there is positive risk transfer. We find that, before the first Greek bailout, the sovereign-to-financial and the financial-to-sovereign risk transfer has been positive, indicating that the countries have entered into a feedback loop. After the bailout, however, the financial-to-sovereign risk transfer for the GIIPS countries becomes insignificant or negatively significant. Such results indicate that the GIIPS countries are the main beneficiaries of the bailouts, and the financial-to-sovereign risk transfer in the GIIPS countries breaks down after the bailouts, while the bailouts have less impact on the risk transfer pattern of other bailout guarantees.

5.3.2. Results of Other EFSF Bailouts (Second Greek Bailout, Irish and Portugal Bailouts)

Table 8 shows the result of the impulse response functions for the Greek sovereign and banking CDS series. The results for the periods of the first bailout are similar to the results in Section 5.3.1, in which the responses of the financial sector to the shocks in the sovereign default risk are positively significant in the period before the first Greek bailout, and vice versa. In contrast, the responses of the sovereign default risk to the shocks in the financial sector become either insignificant or negatively significant in the short run, indicating that risk has been transferred from the financial sector to the government balance sheet. However, when analyzing the results in the application period of the second Greek bailout, the responses of the financial sector default risk to the shocks in the sovereign default risk are insignificant, and so are the responses of the sovereign default risk to the shocks in the financial sector. Such results indicate that the risk transfer only happens in the period of the first Greek bailout.

[Insert Table 8]

The "Greek effect" indicates that the default risk of other countries such as Ireland and Portugal has been priced or perceived by bond investors during the first Greek bailout, and such default risk transfer becomes insignificant when other countries issue their own bailouts. Table 9 exhibits the result of the IRFs for the government and banking default risks in Ireland for the four sub-periods. The results are ambiguous compared to the results of Greece. In the period before the Irish bailout application, the responses of the financial sector to the shocks in the government default risk are positively significant, but the responses of the government to the shocks in the financial sector are insignificant. For example, the responses of *Bank of Ireland* to the impulses in *Irish Sov* after 1, 2, 5 and 22 days are significantly positive (0.09, 0.17, 0.38 and 0.94, respectively), and the responses of *Irish Sov* to the impulses in *Bank of Ireland* after 1, 2, 5 and 22 days become insignificant (-0.05, -0.09, -0.21 and -0.51, respectively). However, in the periods of application, bailout and post-bailout, there is no clear pattern of risk transfer between

the sovereign and financial sectors. But since the CDS spreads of both the sovereign and banking debts have been increasing, the results show that the crisis in the financial sector has not been relieved after the bailout to the government of Ireland.

[Insert Table 9]

Table 10 shows the results of the IRFs for the sovereign and banking CDS series in Portugal. In the period before bailout application and the post-bailout period, the responses of banking default risk to the shocks in the government default risk are positively significant, while the responses of the government default risk to the shocks in the financial sector are all insignificant. For example, for the pair of *Portuguese Sov* and *Banco Comercial Portugues*, in the period of pre-bailout, the responses of *Banco Comercial Portugues* to the impulses in *Portuguese Sov* after 1, 2, 5 and 22 days are significantly positive (0.26, 0.38, 0.51 and 0.74, respectively), and the responses of *Portuguese Sov* to the impulses in *Banco Comercial Portugues* after 1, 2, 5 and 22 days are insignificant (-0.17, -0.20, -0.13 and 0.09, respectively). However, in both the application and bailout periods, the responses of the financial sector to the shocks in the sovereign default risk become insignificant, and vice versa.

[Insert Table 10]

When sub-periods are reset for Ireland and Portugal according to their own bailouts received, respectively, the default risk transfer from the banking sector to the government is not significant, compared to the results in Section 5.3.1, that the bank-to-government risk transfer is significantly positive. The risk transfer from the financial sector to the sovereign default risk is significant to the countries that have potential defaults, only when the first Greek bailout is issued. Such difference indicates that the risk of default had already been priced for Ireland, Portugal and Spain. Given the Greek experience, bond investors have perceived that these countries might also request and receive the bailouts from the EFSF guarantees in the future. For Ireland and Portugal, the transfer of default risk in the banking sector to the government was priced after the Greek bailout was approved. Thus by the time these countries requested their own bailouts, such effect disappears.

6. Conclusion

In this paper, we use different approaches to examine the structural changes of the relationship between the sovereign and the financial institutions' CDS series during the European sovereign debt crisis. We first apply a bivariate VEC model with a threshold effect of Hansen and Seo (2002) to test the cointegrating relationship in two regimes, *typical* and *atypical* regimes. Our findings show that the threshold determines the regime shifts, and that the *atypical* regime is around the global credit crunch in 2007-2008 and the 2010 Eurozone crisis.

We then use the models of Gregory and Hansen (1996) to estimate the unknown timing of the structural breaks in each bivariate relationship. We find that the significant breakpoints are close to the four bailouts (G1, I, P G2) carried out by the EFSF. Accordingly, we apply the four bailouts from the EFSF as the breakpoints for all the countries and investigate the changes in the default risk transfer in the pre- and post-bailout periods.

Before the first Greek bailout (G1), we find that the two-way feedback effect exists between the sovereign and financial sectors in both the short and the long runs. After the first Greek bailout (G1), the shocks in the financial sector either exert significantly negative impacts or lose influences on the sovereign sector. In a sharp contrast, the later bailouts from the EFSF (G2, I and P) do not show this pattern change in the two-way risk transfer. Importantly, the two-way feedback is not even significant during the pre-bailout periods for the later bailouts.

Our evidence suggests that the first Greek bailout helps alleviate the financial systemic risk and successfully transfers the aggregated sovereign risk to the EFSF, which is supported together by the Eurozone guarantee countries. However, since investors have perceived the forthcoming bailouts, and the two-way risk transfer has been priced after the first Greek bailout, the two-way feedback loop is not shown in later EFSF bailouts.

There are limitations to the EFSF bailout programme, as the EFSF only raises funds after an official aid request is made by a country. The EFSF funds are given to the governments, which in turn bailout individual institutions in the country, leading

to increases in the government default risk. The EFSF has been improved to become the European Stability Mechanism (ESM), a permanent bailout funding programme, and the current Spanish bailout has been passed on to the ESM in early 2013. The funds from the ESM are transferred in the form of ESM notes to individual banks through FROB, and these banks have been confirmed to receive certain amounts according to the bailout scheme. Further research could focus on the Spanish case in order to make comparison for different bailout policies.

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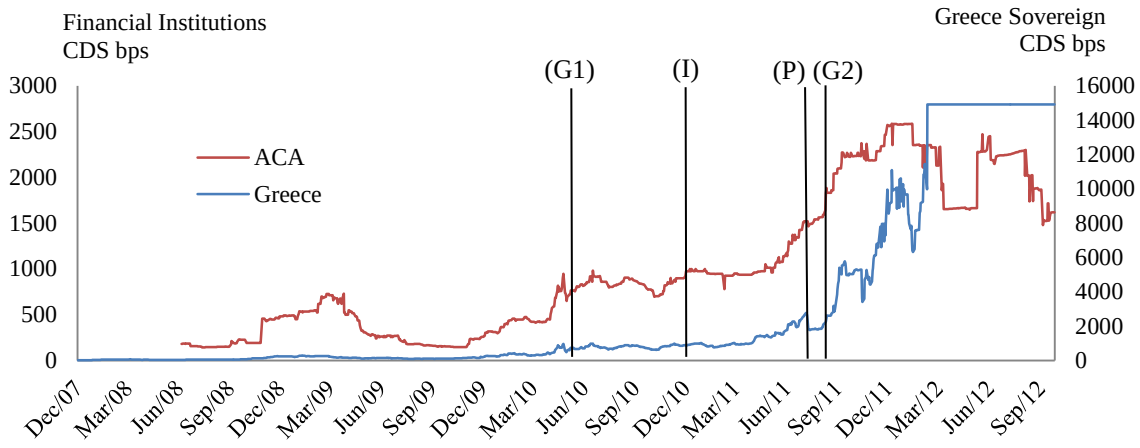
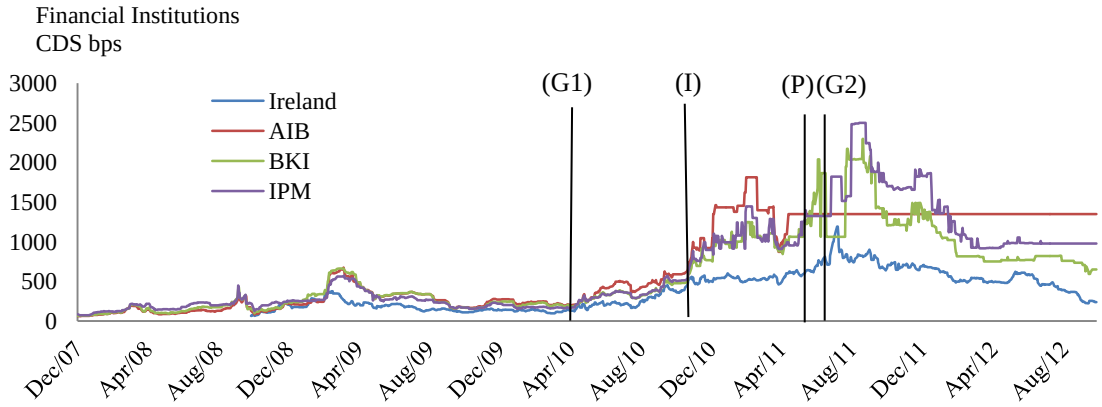
Panel A. CDS Spreads of Greek Sovereign Debt and Domestic Financial Institution



Panel B. CDS Spreads of Irish Sovereign Debt and Domestic Financial Institutions



Panel C. CDS Spreads of Portugal Sovereign Debt and Domestic Financial Institutions

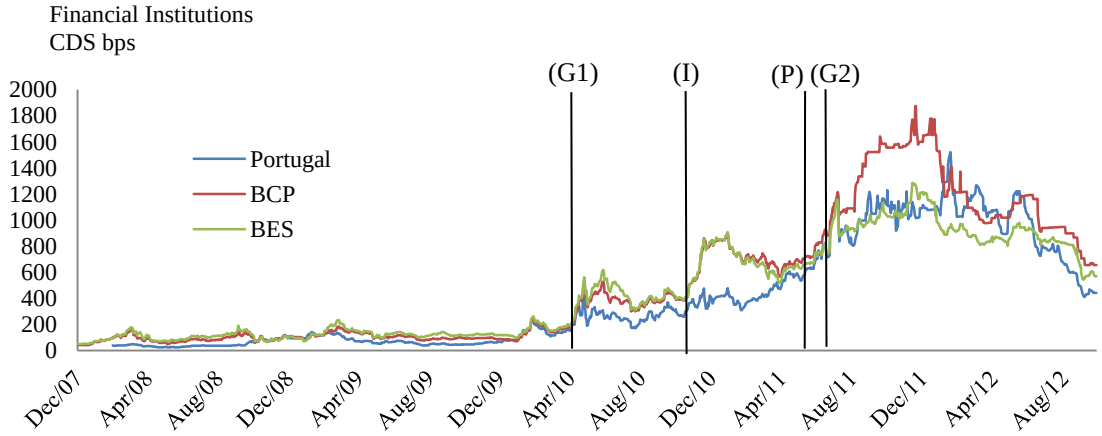


Figure 2. CDS Spreads for Greece, Ireland and Portugal

Four settlement dates of EFSF bailouts to Greece, Ireland and Portugal are denoted as G1, I, P, and G2. The first Greek bailout is on 9 May 2010 (G1), and Greece officially requested for the second bailout on 21 July 2011 (G2). The settlement date of the tranche of Irish bailout is on 25 January 2011 (I), and for Portugal is on 15 June 2011 (P). Since Greek debt restructuring triggered approximately $3.2bn CDS credit protection payouts on Greek sovereign debt in early March 2012, the sovereign CDS spread of Greece has remained unchanged. The three-letter variables represent domestic financial institutions in the corresponding country. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland) and Banco Comercial Portugues and Banco Espirito Santo (Portugal). See Supplementary Documents for the detailed results of other financial institutions in these countries.

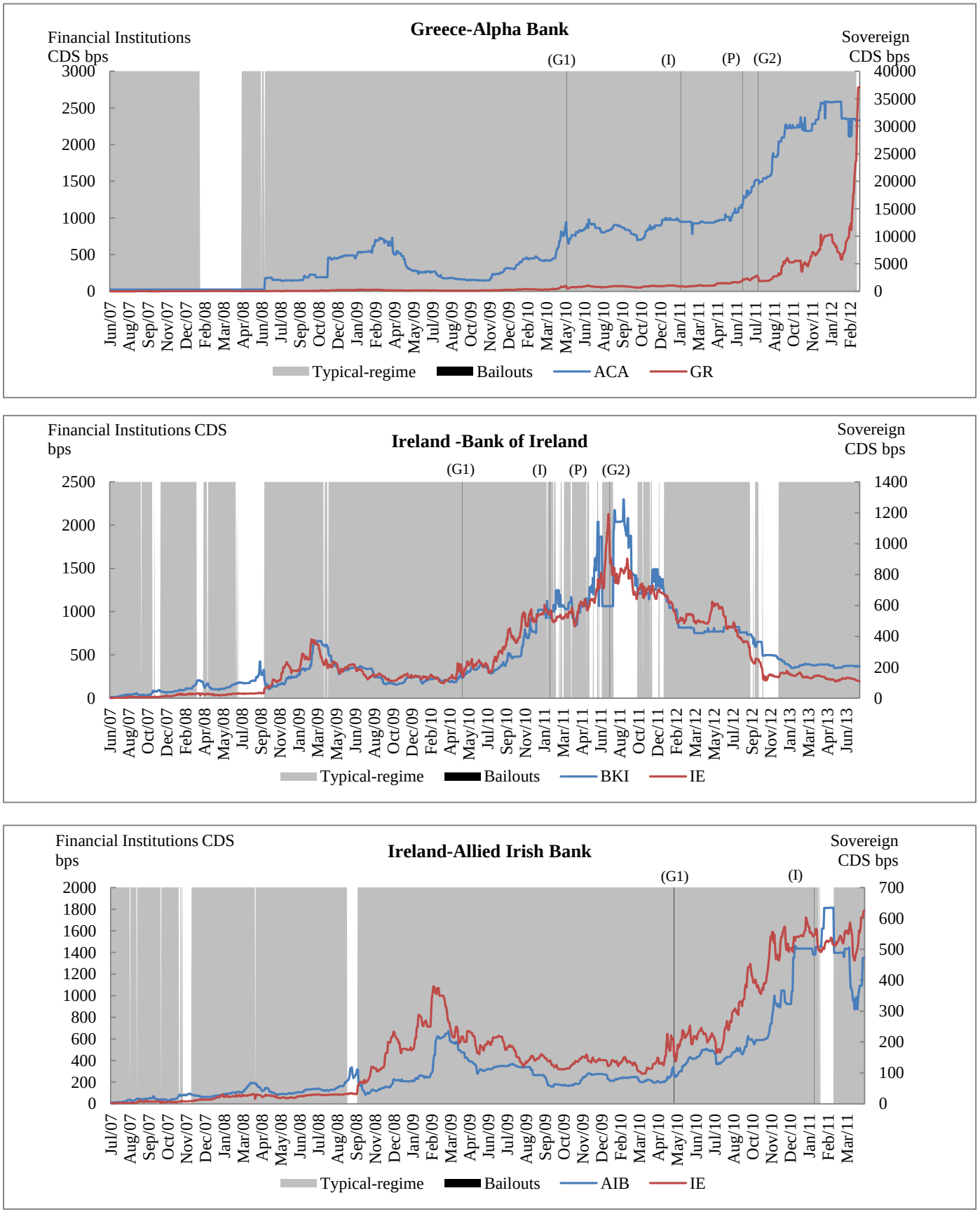
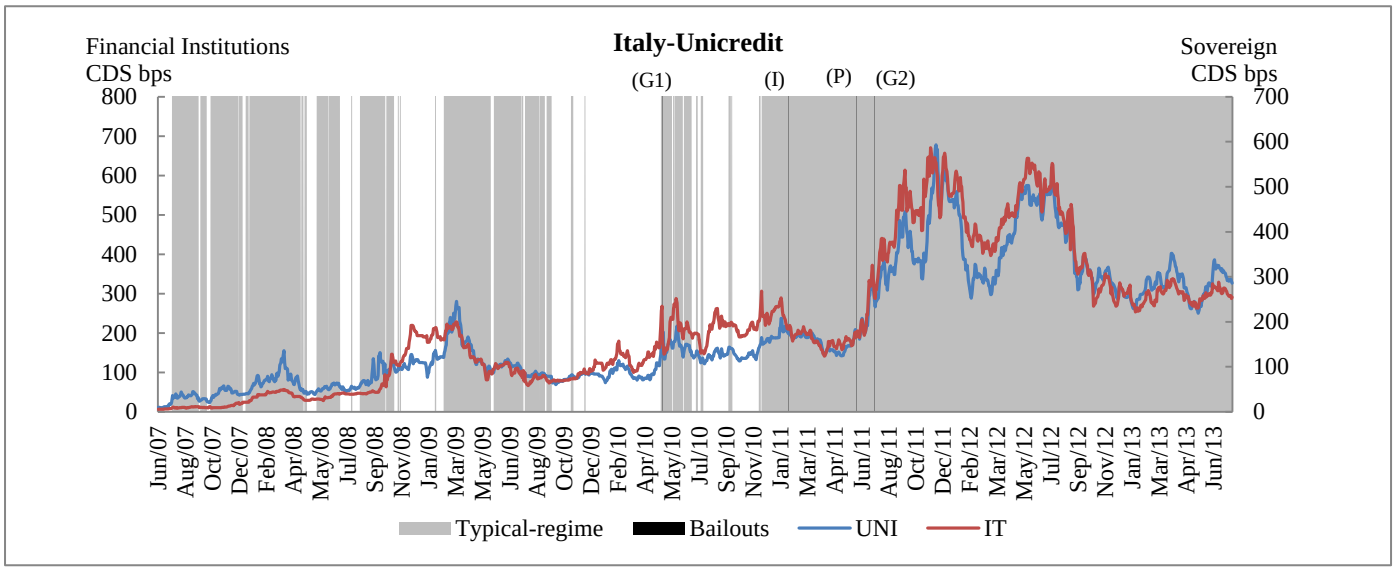
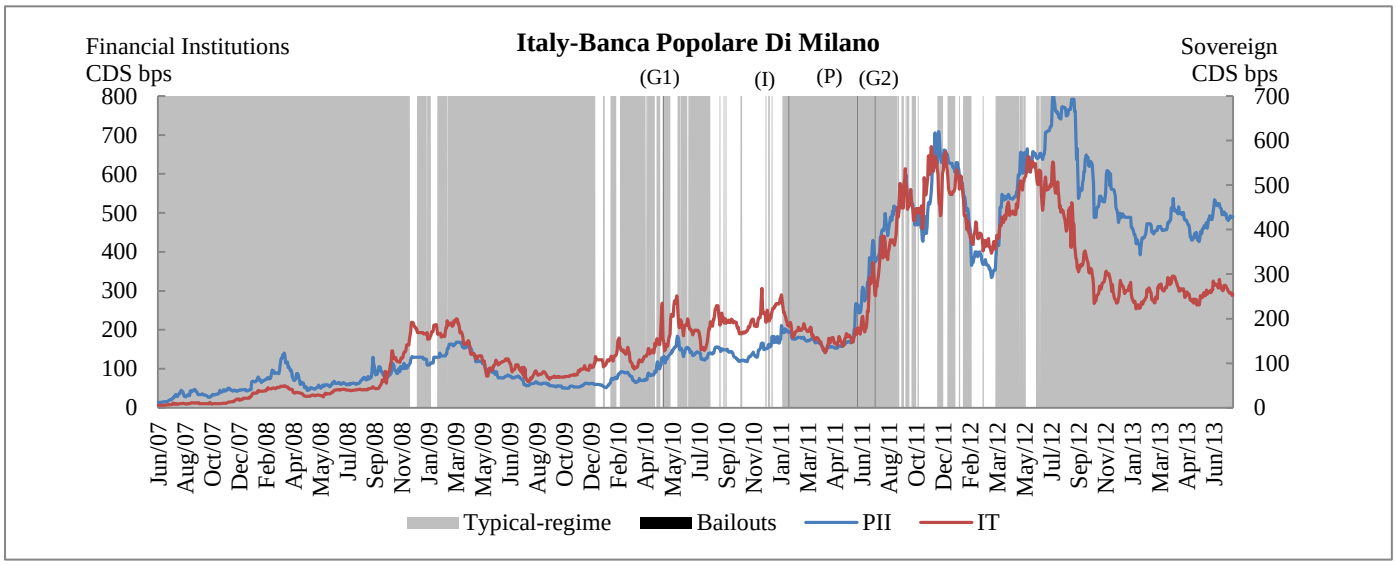


Figure 3. CDS Spreads of Sovereign Debts and Financial Institutions in *Typical* and *Atypical* Regimes for GIIPS.

Four settlement dates of EFSF bailouts to Greece, Ireland and Portugal are denoted as G1, I, P, and G2. The grey parts indicate the *typical* regime, and the white parts show the *atypical* regime. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal) and Banco Santander and Banco De Sabadell (Spain). See Supplementary Documents for the detailed results of other financial institutions in these countries.





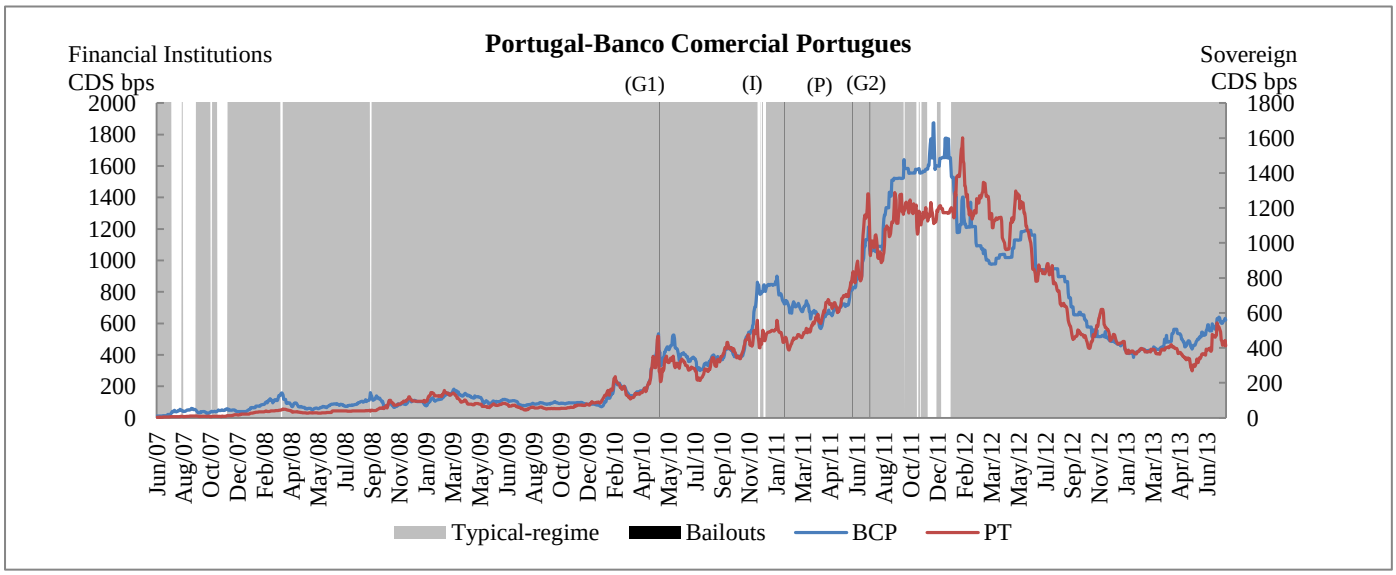
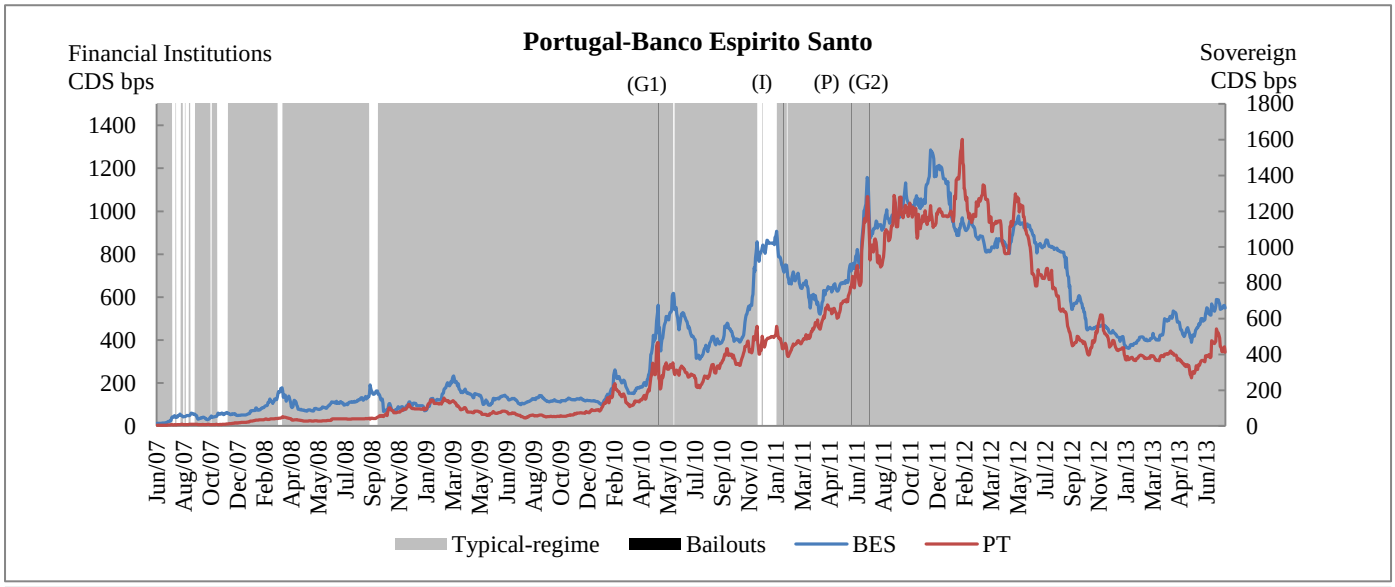
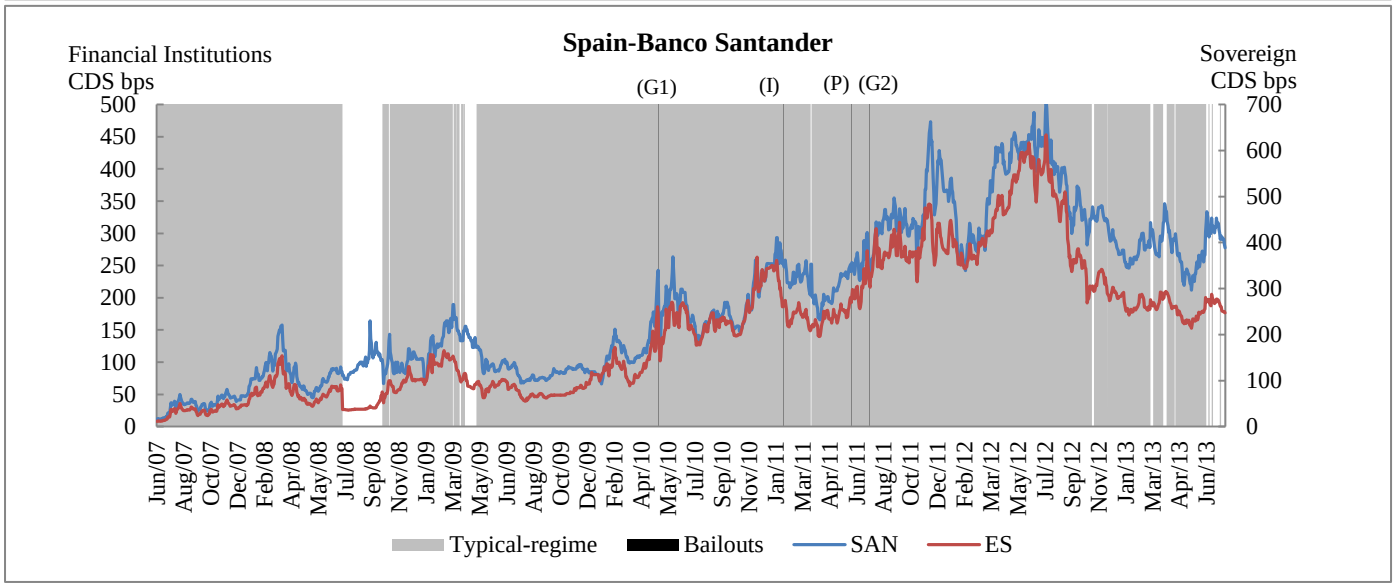


Figure 3 *(continued)*





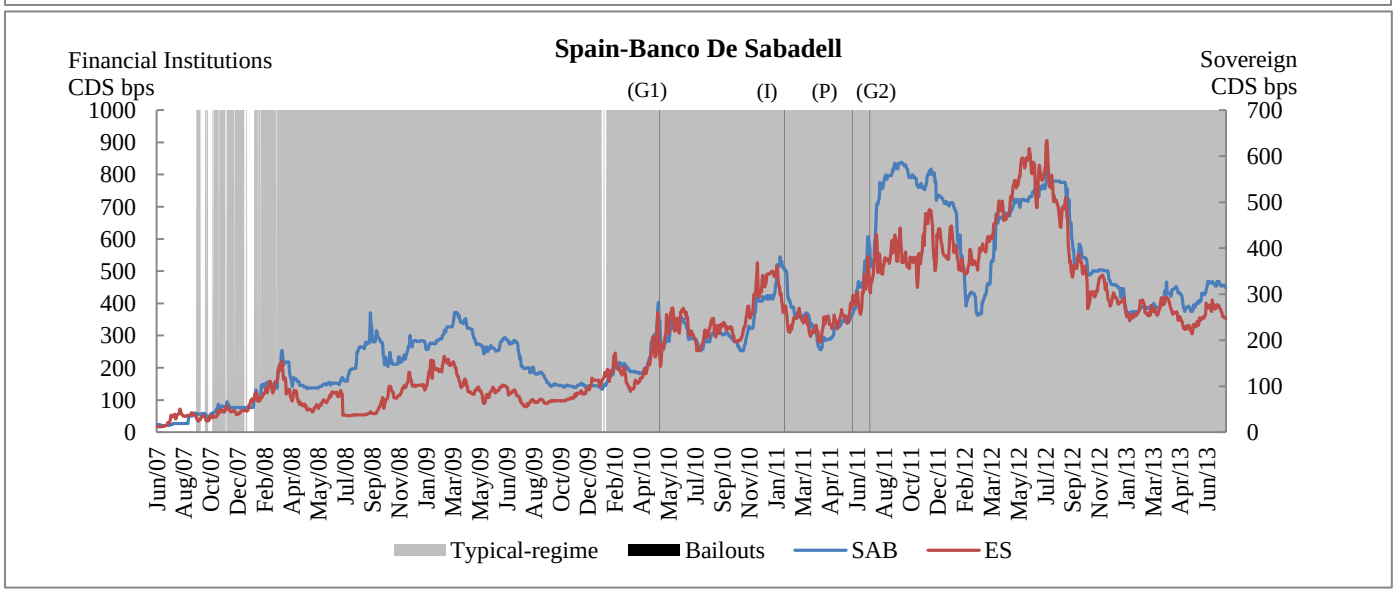


Figure 3 *(continued)*

Table 1. Cointegration Analysis of Linear VECM Estimates for GIIPS Countries

Testing for cointegration

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \mu + \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} w_{t-1} + \sum_{i=1}^{l} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t ,$$

where $w_{t-1} = cds_{Sov,t-1} + \beta cds_{Fi,t-1}$.

β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. The test statistics with * indicate significant at the 0.1 level. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal) and Banco Santander and Banco De Sabadell (Spain). See Supplementary Documents for the detailed results of other financial institutions in these countries.

$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration	
					β	Constant
Greece	0.01*	0.00*	0.13*	-0.01*	1.42	0.24
Alpha Bank	0.02*	0.01*	0.04*	-0.02*		
Ireland	0.03*	0.00*	-0.19	0.10*	2.13	0.44
Bank of Ireland	0.06*	0.01*	0.02	-0.04*		
Ireland	0.01*	0.00*	-0.22	0.15*	1.86	0.42
Allied Irish Banks	0.05*	0.01*	-0.03	0.17*		
Italy	0.01*	0.00*	-0.01*	0.13*	1.67	0.22
Unicredit	0.05*	0.01*	0.02*	0.12*		
Italy	0.02*	0.00*	0.02*	0.14*	-0.03	1.23
Banca Popolare Di Milano	0.01*	0.00*	0.08*	0.11*		
Portugal	0.01*	0.00*	0.10*	0.11*	1.43	0.17
Banco Comercial Portugues	0.03*	0.01*	0.12*	0.13*		
Portugal	0.02*	0.00*	0.10*	0.11*	1.62	0.13
Banco Espirito Santo	0.05*	0.01*	0.09*	0.19*		
Spain	0.02*	0.01*	0.03*	0.10*	1.33	0.12
Banco Santander	0.04*	0.02*	0.13*	0.05*		
Spain	0.01*	0.00*	0.08*	0.08*	1.45	0.23
Banco De Sabadell	0.03*	0.01*	0.10*	0.02*		

Table 2. Cointegration Analysis of *Typical* Regime for GIIPS Countries

Testing for cointegration

$$\begin{pmatrix}\Delta cds_{Sov,t}\\ \Delta cds_{Fi,t}\end{pmatrix}=\begin{cases}\mu_1+\begin{pmatrix}\alpha_{Sov,1}\\ \alpha_{Fi,1}\end{pmatrix}w_{t-1}+\sum_{i=1}^{l}\begin{bmatrix}\gamma_{SovSov,i,1} & \gamma_{SovFi,i,1}\\ \gamma_{FiSov,i,1} & \gamma_{FiFi,i,1}\end{bmatrix}\begin{pmatrix}\Delta cds_{Sov,t-i}\\ \Delta cds_{Fi,t-i}\end{pmatrix}+u_{1t}, & if\ w_{t-1}\le\gamma,\\ \mu_2+\begin{pmatrix}\alpha_{Sov,2}\\ \alpha_{Fi,2}\end{pmatrix}w_{t-1}+\sum_{i=1}^{l}\begin{bmatrix}\gamma_{SovSov,i,2} & \gamma_{SovFi,i,2}\\ \gamma_{FiSov,i,2} & \gamma_{FiFi,i,2}\end{bmatrix}\begin{pmatrix}\Delta cds_{Sov,t-i}\\ \Delta cds_{Fi,t-i}\end{pmatrix}+u_{2t}, & if\ w_{t-1}>\gamma,\end{cases}$$

where $w_{t-1}=cds_{Sov,t-1}+\beta cds_{Fi,t-1}$.

β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. The test statistics with * indicate significant at the 0.1 level. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal) and Banco Santander and Banco De Sabadell (Spain). See Supplementary Documents for the detailed results of other financial institutions in these countries.

$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration			
Greece	0.00*	0.01*	0.10*	-0.01*	$cds_{Sov,t}\le$	1.45	$cds_{Fi,t}$	-1.00
Alpha Bank	0.01*	0.02*	0.04*	-0.02*				
Ireland	0.01*	0.00*	-0.06*	0.09*	$cds_{Sov,t}>$	1.57	$cds_{Fi,t}$	-4.71
Bank of Ireland	0.03*	0.01*	0.01*	-0.03				
Ireland	0.01*	0.00*	-0.08*	0.10*	$cds_{Sov,t}>$	1.42	$cds_{Fi,t}$	-4.10
Allied Irish Banks	0.04*	0.01*	-0.04*	0.16*				
Italy	0.02*	0.00*	0.13*	0.05*	$cds_{Sov,t}\le$	1.76	$cds_{Fi,t}$	-3.65
Unicredit	0.04*	0.01*	0.06*	0.05*				
Italy	0.01*	0.00*	-0.01*	0.16*	$cds_{Sov,t}\le$	0.69	$cds_{Fi,t}$	+1.83
Banca Popolare Di Milano	0.00*	0.00*	0.06*	0.14*				
Portugal	0.02*	0.01*	0.12*	0.09*	$cds_{Sov,t}>$	1.37	$cds_{Fi,t}$	-3.05
Banco Comercial Portugues	0.03*	0.01*	0.16*	0.14*				
Portugal	0.02*	0.01*	0.12*	0.08*	$cds_{Sov,t}>$	1.42	$cds_{Fi,t}$	-3.33
Banco Espirito Santo	0.04*	0.01*	0.13*	0.18*				
Spain	0.03*	0.03*	0.02*	0.11*	$cds_{Sov,t}>$	1.20	$cds_{Fi,t}$	-1.27
Banco Santander	0.04*	0.04*	0.18*	0.02*				
Spain	0.00*	0.00*	0.08*	0.11*	$cds_{Sov,t}\le$	1.46	$cds_{Fi,t}$	-2.49
Banco De Sabadell	0.01*	0.00*	0.10*	0.07*				

Table 3. Cointegration Analysis of *Atypical* Regime for GIIPS Countries

Testing for cointegration

$$\begin{pmatrix}\Delta cds_{Sov,t}\\ \Delta cds_{Fi,t}\end{pmatrix}=\begin{cases}\mu_1+\begin{pmatrix}\alpha_{Sov,1}\\ \alpha_{Fi,1}\end{pmatrix}w_{t-1}+\sum_{i=1}^{l}\begin{bmatrix}\gamma_{SovSov,i,1} & \gamma_{SovFi,i,1}\\ \gamma_{FiSov,i,1} & \gamma_{FiFi,i,1}\end{bmatrix}\begin{pmatrix}\Delta cds_{Sov,t-i}\\ \Delta cds_{Fi,t-i}\end{pmatrix}+u_{1t}, & if\ w_{t-1}\le\gamma,\\ \mu_2+\begin{pmatrix}\alpha_{Sov,2}\\ \alpha_{Fi,2}\end{pmatrix}w_{t-1}+\sum_{i=1}^{l}\begin{bmatrix}\gamma_{SovSov,i,2} & \gamma_{SovFi,i,2}\\ \gamma_{FiSov,i,2} & \gamma_{FiFi,i,2}\end{bmatrix}\begin{pmatrix}\Delta cds_{Sov,t-i}\\ \Delta cds_{Fi,t-i}\end{pmatrix}+u_{2t}, & if\ w_{t-1}>\gamma,\end{cases}$$

where $w_{t-1}=cds_{Sov,t-1}+\beta cds_{Fi,t-1}$.

β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. The test statistics with * indicate significant at the 0.1 level. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal) and Banco Santander and Banco De Sabadell (Spain). See Supplementary Documents for the detailed results of other financial institutions in these countries.

$\Delta cds_{Sov/Fi}$	μ	α	γ_{Sov}	γ_{Fi}	Cointegration			
Greece	-0.01*	-0.02*	0.50*	-41.75	$cds_{Sov,t}>$	1.45	$cds_{Fi,t}$	-1.00
Alpha Bank	-0.22	-0.33	-0.10	-39.96				
Ireland	-0.21	-0.04*	-0.58	0.09*	$cds_{Sov,t}\le$	1.57	$cds_{Fi,t}$	-4.71
Bank of Ireland	0.26	0.06*	0.06*	-0.01*				
Ireland	-0.20	-0.05	-0.91	0.46	$cds_{Sov,t}\le$	1.42	$cds_{Fi,t}$	-4.10
Allied Irish Banks	0.60	0.14*	0.04*	0.25				
Italy	0.04*	0.01*	-0.33	0.34	$cds_{Sov,t}>$	1.76	$cds_{Fi,t}$	-3.65
Unicredit	0.11*	0.03*	-0.1	0.28*				
Italy	0.53	-0.28	0.37*	0.01*	$cds_{Sov,t}>$	0.69	$cds_{Fi,t}$	+1.83
Banca Popolare Di Milano	-0.23	0.12*	0.18*	-0.10*				
Portugal	-0.53	-0.17*	0.01*	0.07*	$cds_{Sov,t}\le$	1.37	$cds_{Fi,t}$	-3.05
Banco Comercial Portugues	0.90	0.29*	-0.18*	0.15*				
Portugal	-0.72	-0.21	0.01	0.05	$cds_{Sov,t}\le$	1.42	$cds_{Fi,t}$	-3.33
Banco Espirito Santo	0.69	0.20*	-0.15*	0.26				
Spain	-0.03*	-0.02*	0.02*	-0.01*	$cds_{Sov,t}\le$	1.20	$cds_{Fi,t}$	-1.27
Banco Santander	-0.04*	-0.02*	-0.04*	-0.02				
Spain	0.00*	-0.01*	0.07	0.01	$cds_{Sov,t}>$	1.46	$cds_{Fi,t}$	-2.49
Banco De Sabadell	0.02*	0.00*	0.00*	-0.13				

Table 4. Impulse Responses in *Typical* and *Atypical* Regimes for GIIPS Countries

A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. The test statistics with * indicate significant at the 0.1 level. The two-letter variables indicate the CDS spreads of sovereign debts, and the three-letter variables are domestic financial institutions. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal) and Banco Santander and Banco De Sabadell (Spain). See Supplementary Documents for the detailed results of other financial institutions in these countries.

		Typical Regime				*Atypical* Regime			
Impulse	Response	1	2	5	22	1	2	5	22
Greece	Alpha Bank	0.04	0.06	0.09*	0.27*	0.00	0.00	0.00	0.00
Alpha Bank	Greece	-0.01	-0.02	-0.04	-0.11	-34.99*	-33.03*	-24.83*	-1.93
Ireland	Bank of Ireland	0.03	0.04*	0.09*	0.27*	0.14*	0.15*	0.27*	0.40*
Bank of Ireland	Ireland	0.11*	0.10*	0.11*	0.13*	0.13*	0.12*	0.19*	0.27*
Ireland	Allied Irish Banks	-0.01	0.00	0.04*	0.19*	-0.02	0.09	0.24*	0.21*
Allied Irish Banks	Ireland	0.16*	0.15*	0.17*	0.24*	0.62*	0.97*	1.19*	1.06*
Italy	Unicredit	0.08*	0.12*	0.19*	0.41*	-0.02	0.08	0.28*	0.56*
Unicredit	Italy	0.08*	0.09*	0.10*	0.13	0.30*	0.26*	0.18*	0.06
Italy	Banca Popolare Di Milano	0.06*	0.07*	0.07*	0.08	0.38*	0.48*	0.45*	0.39*
Banca Popolare Di Milano	Italy	0.15*	0.17*	0.19*	0.25	0.28*	0.47*	0.59*	0.51*
Portugal	Banco Comercial Portugues	0.15*	0.21*	0.27*	0.50*	0.30*	0.54*	0.52*	0.47*
Banco Comercial Portugues	Portugal	0.10*	0.12*	0.12*	0.07*	0.32*	0.38*	0.33*	0.30*
Portugal	Banco Espirito Santo	0.14*	0.19*	0.26*	0.49*	0.11	0.29*	0.39*	0.35*
Banco Espirito Santo	Portugal	0.08*	0.10*	0.09*	0.01	0.44*	0.57*	0.57*	0.52*
Spain	Banco Santander	0.22*	0.28*	0.41*	0.84*	0.03	0.06	0.13	0.22*
Banco Santander	Spain	0.09*	0.06	-0.01	-0.29*	0.12	0.33*	0.72*	1.19
Spain	Banco De Sabadell	0.12*	0.14*	0.17*	0.27*	0.05	0.10	0.20*	0.42
Banco De Sabadell	Spain	0.08*	0.09*	0.09*	0.09	0.10	0.12	0.16	0.24

Table 5. Testing Cointegration with Regime Shifts

Panel A shows an example of test for cointegration of two variables, *Greek Sov* and *Alpha Bank*. Panel B shows the exact dates of the significant breakpoints obtained from the level shift (C) and regime shift (C/S) models. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal) and Banco Santander and Banco De Sabadell (Spain). See Supplementary Documents for the detailed results of other financial institutions in these countries. The test statistics with * and ** indicate significance at the 10% and 5% levels, respectively. The breakpoints show the positions of the smallest test statistics in the whole time period, and the exact dates are shown if the estimates are significant.

Level shift (C): $cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha^{\mathrm{T}} cds_{Sov,t} + e_t$

Regime shift (C/S): $cds_{Fi,t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha_1^{\mathrm{T}} cds_{Sov,t} + \alpha_2^{\mathrm{T}} cds_{Sov,t}\varphi_{t\tau} + e_t$

Panel A. Testing cointegration of Greece and Alpha Bank with regime shifts

		Test stat.	Breakpoint	Date
ADF	Level shift	-4.06	(0.27)	
	Regime shift	-4.85*	(0.85)	21-09-2011
Z_t	Level shift	-3.8	(0.85)	
	Regime shift	-5.55**	(0.37)	12-05-2010
Z_a	Level shift	-28.65	(0.85)	
	Regime shift	-60.6**	(0.37)	12-05-2010

Panel B. Estimated breakpoints for the GIIPS countries

Variables		Level shift (C)	Regime shift(C/T)	Actual EFSF bailout date
Greece	Alpha Bank	12-05-2010	21-09-2011	09-05-2010 (G1) / 21-07-2011 (G2)
Ireland	Bank of Ireland	25-11-2010	29-12-2010	25-01-2011 (I)
Ireland	Allied Irish Banks	09-12-2010	09-12-2010	25-01-2011 (I)
Italy	Unicredit	27-12-2010	11-01-2011	-
Italy	Banca Popolare Di Milano	11-01-2011	24-01-2011	-
Portugal	Banco Comercial Portugues	21-12-2009	21-12-2009	15-06-2011 (P)
Portugal	Banco Espirito Santo	11-12-2009	04-01-2010	15-06-2011 (P)
Spain	Banco Santander	21-01-2010	12-01-2011	-
Spain	Banco De Sabadell	06-11-2009	06-11-2009	-

Table 6. Cointegration Analysis of GIIPS Countries and Germany

The table shows the results from the following cointegration model:

$$\begin{pmatrix} \Delta cds_{Sov,t} \\ \Delta cds_{Fi,t} \end{pmatrix} = \begin{pmatrix} \alpha_{Sov} \\ \alpha_{Fi} \end{pmatrix} \left(\beta_{Sov} cds_{Sov,t-1} + \beta_{Fi} cds_{Fi,t-1} + \beta_0 \right) + \sum_{i=1}^{p-1} \begin{bmatrix} \gamma_{SovSov,i} & \gamma_{SovFi,i} \\ \gamma_{FiSov,i} & \gamma_{FiFi,i} \end{bmatrix} \begin{pmatrix} \Delta cds_{Sov,t-i} \\ \Delta cds_{Fi,t-i} \end{pmatrix} + u_t \, .$$

The table only presents the cointegration analysis for the bi-variables that are tested to be cointegrated in the Johansen's trace tests. The test statistics with * indicate significant at the 10% level. *Sov* indicates a sovereign debt, and *Fi* indicates a financial institution from the country. β_Sov is set as 1. β coefficients measure the long-run relationships between the two variables, and the α coefficients are adjustment speeds of the two variables towards their long-term relationships. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal), Banco Santander and Banco De Sabadell (Spain) and Deutsche Bank and Hannover Re (Germany). See Supplementary Documents for the detailed results of other financial institutions in these countries.

Panel A. Before first Greek bailout

Sovereign	Financial Institution	*α_Sov*	*α_Fi*	*β_Fi*	Constant
Greece	Alpha Bank	0.00	0.02*	-0.83*	-0.24
Ireland	Bank of Ireland	0.00	0.01*	-3.30*	13.81
Ireland	Allied Irish Banks	-	-	-	-
Italy	Unicredit	-	-	-	-
Italy	Banca Popolare Di Milano	0.00*	0.00*	-21.98*	96.60
Portugal	Banco Comercial Portugues	0.00	0.02*	-1.41*	2.45
Portugal	Banco Espirito Santo	0.00	0.01*	-1.56*	3.47
Spain	Banco Santander	-	-	-	-
Spain	Banco De Sabadell	-0.00*	0.00	3.59*	-24.48
Germany	Deutsche Bank	0.00	0.01*	-3.94*	14.99
Germany	Hannover Re	0.00	0.00*	-13.22*	53.22

Panel B. After first Greek bailout

Sovereign	Financial Institution	*α_Sov*	*α_Fi*	*β_Fi*	Constant
Greece	Alpha Bank	-0.01	0.01*	-2.08*	7.13
Ireland	Bank of Ireland	-	-	-	-
Ireland	Allied Irish Banks	0.01	0.02*	-1.30*	2.83
Italy	Unicredit	-0.01	0.01	-0.92*	-0.50
Italy	Banca Popolare Di Milano	-0.03*	-0.01	-0.68*	-1.83
Portugal	Banco Comercial Portugues	0.00	0.02*	-1.05*	0.63
Portugal	Banco Espirito Santo	0.01*	0.01*	-1.99*	6.84
Spain	Banco Santander	-	-	-	-
Spain	Banco De Sabadell	-0.03	0.03*	-0.61*	-1.98
Germany	Deutsche Bank	0.00	0.02*	-1.50*	3.26
Germany	Hannover Re	0.00	0.00*	-30.31*	139.55

Table 7. Impulse Responses before and after the First Greek Bailout

The table shows the impulse responses from the model: $\begin{pmatrix} cds_{Sov,t} \\ cds_{Fi,t} \end{pmatrix} = v + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{SovSov,i} & \alpha_{SovFi,i} \\ \alpha_{FiSov,i} & \alpha_{FiFi,i} \end{bmatrix} \begin{pmatrix} cds_{Sov,t-i} \\ cds_{Fi,t-i} \end{pmatrix} + u_t$. For each country (except for Greece with one financial institution), we show as examples the results of the largest and the smallest financial institutions by total assets. These financial institutions are Alpha Bank (Greece), Bank of Ireland and Allied Irish Banks (Ireland), Unicredit and Banca Popolare De Milano (Italy), Banco Comercial Portugues and Banco Espirito Santo (Portugal), Banco Santander and Banco De Sabadell (Spain) and Deutsche Bank and Hannover Re (Germany). A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. *t*=1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10% level. The IRF results of bi-variables not cointegrated are also presented for comparisons.

		Before Bailout				After Bailout			
Impulse	Response	*t*=1	*t*=2	*t*=5	*t*=22	*t*=1	*t*=2	*t*=5	*t*=22
Greece	Alpha Bank	0.09	0.13	0.18*	0.39*	0.08*	0.07*	0.10*	0.19*
Alpha Bank	Greece	0.01	0.01	0.02	0.06	-0.21*	-0.13	-0.06	0.29
Ireland	Bank of Ireland	0.05*	0.06*	0.08*	0.17*	0.28*	0.32*	0.46*	0.82*
Bank of Ireland	Ireland	0.14*	0.14*	0.12*	-0.05	0.03	0.03	0.04	0.06
Ireland	Allied Irish Banks	-0.04	-0.07	-0.06	0.12	0.01	0.12	0.17	0.40*
Allied Irish Banks	Ireland	0.16*	0.19*	0.26*	-0.15	0.06	0.05	0.19	0.02
Italy	Unicredit	-0.05	-0.04	0.03	0.31*	0.21*	0.33*	0.34*	0.38
Unicredit	Italy	0.18*	0.13*	0.11*	-0.04	-0.07	-0.13	-0.09	0.12
Italy	Banca Popolare Di Milano	0.07*	0.07*	0.09*	0.15*	0.23*	0.39*	0.30*	0.07
Banca Popolare Di Milano	Italy	0.20*	0.19*	0.15*	-0.05	-0.01	-0.10	-0.02	0.31*
Portugal	Banco Comercial Portugues	0.24*	0.32*	0.38*	0.52*	0.24*	0.35*	0.32*	0.45*
Banco Comercial Portugues	Portugal	0.11*	0.14*	0.11	-0.09	0.06	-0.07	-0.02	0.01
Portugal	Banco Espirito Santo	0.22*	0.30*	0.36*	0.48*	0.20*	0.25*	0.19*	0.34*
Banco Espirito Santo	Portugal	0.10*	0.11*	0.07	-0.18	0.11	0.00	-0.12	-0.39
Spain	Banco Santander	0.16*	0.16*	0.19*	0.23*	0.25*	0.42*	0.34*	0.55*
Banco Santander	Spain	0.18*	0.16*	0.11*	-0.09	0.13*	0.00	-0.07	-0.07
Spain	Banco De Sabadell	0.09*	0.10*	0.11*	0.18*	0.15*	0.23*	0.34*	0.46*
Banco De Sabadell	Spain	0.17*	0.16*	0.12*	-0.08	0.06	0.00	-0.11	0.14
Germany	Deutsche Bank	0.08*	0.11*	0.14*	0.20*	0.06	0.09	0.14*	0.31*
Deutsche Bank	Germany	0.07*	0.09*	0.07	-0.02	0.06	0.06	0.06	0.00
Germany	Hannover Re	0.06	0.01	-0.01	0.03	0.00	0.04	-0.15	-0.10
Hannover Re	Germany	0.03	0.02	0.00	-0.10	0.18*	0.14	0.01	0.03

Table 8. Impulse Responses of Greece for the First and Second Greek Bailouts

A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. *t*=1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10% level. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Impulse	Response	*t*=1	*t*=2	*t*=5	*t*=22
		Panel A. Whole period			
Greece	Alpha Bank	0.09*	0.07*	0.07*	0.07*
Alpha Bank	Greece	-0.02	-0.01	0.00	0.06
		Panel B. First Greek bailout			
		Before bailout (19/11/2009-07/05/2010)			
Greece	Alpha Bank	0.06*	0.12*	0.24*	0.50*
Alpha Bank	Greece	0.10	0.19	0.40	0.82
		Bailout period (10/05/2010-20/07/2011)			
Greece	Alpha Bank	0.19*	0.18*	0.27*	0.54*
Alpha Bank	Greece	-0.02	-0.05	-0.13	-0.42
		Panel C. Second Greek bailout			
		Application period (21/07/2011-20/02/2012)			
Greece	Alpha Bank	0.01	0.02	0.03	0.06
Alpha Bank	Greece	-0.59*	-0.15	-0.10	0.38

Table 9. Impulse Responses of Ireland for the Irish Bailout

A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. *t*=1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10% level. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Impulse	Response	*t*=1	*t*=2	*t*=5	*t*=22
	Panel A. Whole period				
Ireland	Bank of Ireland	0.19*	0.22*	0.33*	0.74*
Bank of Ireland	Ireland	0.02	0.02	0.01	-0.02
Ireland	Allied Irish Banks	0.01*	0.03*	0.07*	0.28*
Allied Irish Banks	Ireland	-0.01*	-0.02*	-0.05*	-0.18
	Panel B. Irish Bailout				
	Before application (19/11/2009-19/11/2010)				
Ireland	Bank of Ireland	0.09*	0.17*	0.38*	0.94*
Bank of Ireland	Ireland	-0.05	-0.09	-0.21	-0.51
Ireland	Allied Irish Banks	0.07*	0.14*	0.33*	0.97*
Allied Irish Banks	Ireland	-0.03	-0.06	-0.13	-0.38
	Application period (22/11/2010-24/01/2011)				
Ireland	Bank of Ireland	0.00	-0.01	-0.01	0.00
Bank of Ireland	Ireland	0.04	0.06	0.08	0.01
Ireland	Allied Irish Banks	-0.37*	-0.60*	-0.85*	-0.34
Allied Irish Banks	Ireland	0.05*	0.09*	0.12*	0.05
	Bailout period (25/01/2011-01/04/2012)				
Ireland	Bank of Ireland	-0.30	-0.47	-0.53	-0.01
Bank of Ireland	Ireland	0.08	0.12*	0.13*	0.00
Ireland	Allied Irish Banks	-0.41*	-0.76*	-1.46*	-1.84
Allied Irish Banks	Ireland	-0.01	-0.02	-0.03	-0.04
	After bailout (04/04/2012-08/10/2012)				
Ireland	Bank of Ireland	0.28*	0.32*	0.42*	0.76*
Bank of Ireland	Ireland	0.03	0.03	0.04	0.06
Ireland	Allied Irish Banks	-0.01	0.01	0.00	0.00
Allied Irish Banks	Ireland	0.27	0.14	0.03	-0.09

Table 10. Impulse Responses of Portugal for the Portugal Bailout

A unit shock in the structural error leads to one standard deviation (in %) increase in the level of the impulse variable. *t*=1, 2, 5, and 22 indicate the lags of variables in each IRF. The test statistics with * indicate significant at the 10% level. The IRF results of bi-variables not cointegrated are also presented for comparisons.

Impulse	Response	*t*=1	*t*=2	*t*=5	*t*=22
	Panel A. Whole period				
Portugal	Banco Comercial Portugues	0.20*	0.27*	0.33*	0.50*
Banco Comercial Portugues	Portugal	-0.07	-0.09	-0.09	-0.05
Portugal	Banco Espirito Santo	0.20*	0.30*	0.26*	0.38*
Banco Espirito Santo	Portugal	-0.07	-0.06	-0.10	-0.31
	Panel B. Portugal bailout				
	Before application (19/11/2009-06/04/2011)				
Portugal	Banco Comercial Portugues	0.26*	0.38*	0.51*	0.74*
Banco Comercial Portugues	Portugal	-0.17	-0.20	-0.13	0.09
Portugal	Banco Espirito Santo	0.23*	0.32*	0.43*	0.67*
Banco Espirito Santo	Portugal	-0.17	-0.21	-0.19	-0.06
	Application period (07/04/2011-14/06/2011)				
Portugal	Banco Comercial Portugues	0.07	0.13	0.25	0.30
Banco Comercial Portugues	Portugal	0.08	0.14	0.27	0.33
Portugal	Banco Espirito Santo	0.15	0.25	0.40	0.30
Banco Espirito Santo	Portugal	0.05	0.09	0.14	0.10
	Bailout period (15/06/2011-17/07/2012)				
Portugal	Banco Comercial Portugues	0.00	0.00	0.00	0.00
Banco Comercial Portugues	Portugal	0.01	0.02	0.04	0.10
Portugal	Banco Espirito Santo	0.13*	0.15*	0.10	-0.08
Banco Espirito Santo	Portugal	0.05	0.06	0.03	-0.07
	After bailout (18/07/2012-08/10/2012)				
Portugal	Banco Comercial Portugues	0.12*	0.22*	0.45*	0.76*
Banco Comercial Portugues	Portugal	-0.07	-0.13	-0.28	-0.47
Portugal	Banco Espirito Santo	0.10*	0.19*	0.40*	0.72*
Banco Espirito Santo	Portugal	-0.02	-0.04	-0.08	-0.15

APPENDICES

Appendix 1

Cointegration Tests before and after the First Greek Bailout

This table shows the results from the Johansen tests statistics. The respective null hypothesis is that the maximum cointegrating rank is 0 or 1. The optimal lag length is shown.

Panel A. Before first Greek bailout

	Variables	Lags	r=0 trace stat.	r=1 trace stat.
Greece	Alpha Bank	2	**6.82**	1.00
Ireland	Bank of Ireland	2	**14.42**	4.05
Ireland	Allied Irish Banks	9	29.73	4.50
Italy	Unicredit	3	26.23	6.21
Italy	Banca Popolare Di Milano	2	**13.69**	5.50
Portugal	Banco Comercial Portugues	2	**12.22**	2.31
Portugal	Banco Espirito Santo	2	**11.82**	3.11
Spain	Banco Santander	2	19.43	7.71
Spain	Banco De Sabadell	2	**13.86**	5.86
Germany	Deutsche Bank	2	**15.03**	2.84
Germany	Hannover Re	3	**10.64**	2.72

Panel B. After first Greek bailout

	Variables	Lags	r=0 trace stat.	r=1 trace stat.
Greece	Alpha Bank	2	**6.66**	0.21
Ireland	Bank of Ireland	2	20.90	6.61
Ireland	Allied Irish Banks	8	**14.59**	5.17
Italy	Unicredit	3	**7.93**	1.56
Italy	Banca Popolare Di Milano	3	**8.99**	1.12
Portugal	Banco Comercial Portugues	4	**7.67**	2.10
Portugal	Banco Espirito Santo	4	**8.19**	1.54
Spain	Banco Santander	4	18.68	5.33
Spain	Banco De Sabadell	6	**12.15**	2.31
Germany	Deutsche Bank	2	**15.03**	2.84
Germany	Hannover Re	3	**10.64**	2.72